

# CMAQ Modeling Updates

The Chesapeake Bay TMDL's  
Midpoint Assessment  
WQGIT Meeting

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**Chesapeake Bay Program**  
*Science, Restoration, Partnership*



## A Short History of the Assessment of Atmospheric Deposition of Nitrogen in the Chesapeake Bay Program

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1985 – “There is no atmospheric deposition of nitrogen.”

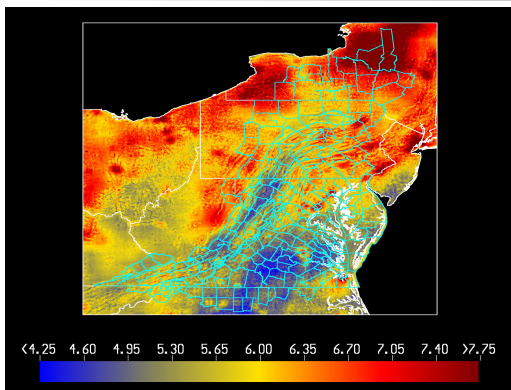
1995 – “Ok, there is some atmospheric deposition of nitrogen.....but its uncontrollable.”

2005 – “Wow! The CAA national program is sure removing a lot of nitrogen from the Chesapeake watershed.” (and other coastal watersheds too).

2015 – The atmospheric deposition of nitrogen to tidal water is an important component of the TMDL allocations. “We couldn’t have done the restoration without the air reductions.”

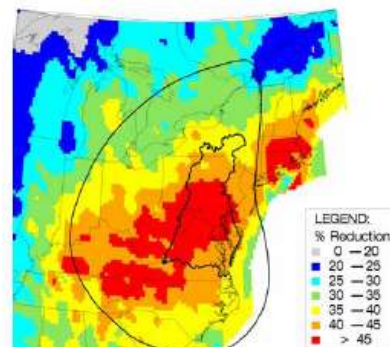


# The Airshed Model – A Combination of a Penn State Regression Model of Wet Deposition and CMAQ

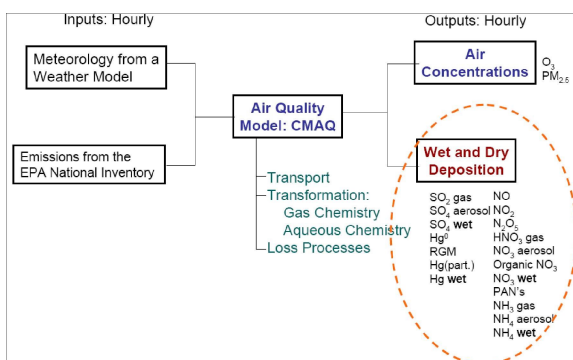


Combining  
a regression  
model of  
wetfall  
deposition...

NOx SIP Reg +  
Tier II Mobile +  
Heavy Duty Diesel Regs  
2020  
ox-N Dep % Change from 1990



...with  
CMAQ  
estimates  
of dry  
deposition  
for the  
base...



...and using the  
power of the  
CMAQ model for  
scenarios.



## New CMAQ Scenarios Prepared for 2002, 2011, 2018, and 2025:

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The 2002, 2011, 2018, and 2025 CMAQ Scenarios are developed with CMAQ 5.0.2 which is the latest release. It has bidirectional ammonia simulated and all scenarios use a full year of hourly meteorology of 2011. The WRF met model is used for the simulation of meteorological data.

The CMAQ model has a domain of all the US including some of southern Canada and some Northern Mexico. The CMAQ uses a 12 km grid size across the domain. The backcast scenario is to 2002.

All future scenarios are projected from the 2011 NEI **emission** inventories and the EGU forecasts were by the IPM model. Mobile emissions were provided by the MOVES T3FRM, which was also used for the Tier 3 Rule. (A new version of MOVES just came out in 2014 but this version was not used.)

The new CMAQ runs will be applied in the integrated models used for Phase III WIPs in 2017.

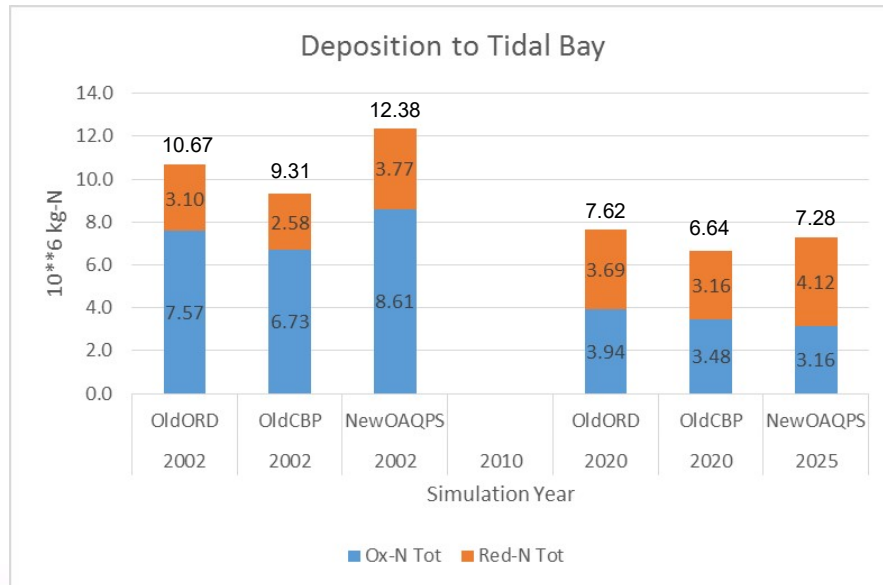


## Summary of Regulations Included

- Power plant Rules: MATS (mercury & air toxics) & CAIR (Clean Air Interstate Rule)
- Industry Rules: CSAPR (Cross State Air Pollution Rule) + local rules, consent decrees, Portland cement plant controls and closures
- Adjustments for new Biofuel futures due to EISA
- Light-Duty Vehicle Tier 2 Rule
- Tier 3 Motor Vehicle Emissions and Fuel Standards Rule
- Heavy Duty Diesel Rule
- Renewable fuel standards (RFS2)
- Light Duty Greenhouse Gas/CAFÉ standards
- Heavy Duty Greenhouse Gas Rule
- Local I/M and National Low **Emission** Vehicles (NLEV)
- Ozone Transport Commission LEV programs (Northeast corridor)
- Clean Air Nonroad Diesel Rule
- Small Engine Spark Ignition Rule
- Locomotive and Marine engine rules



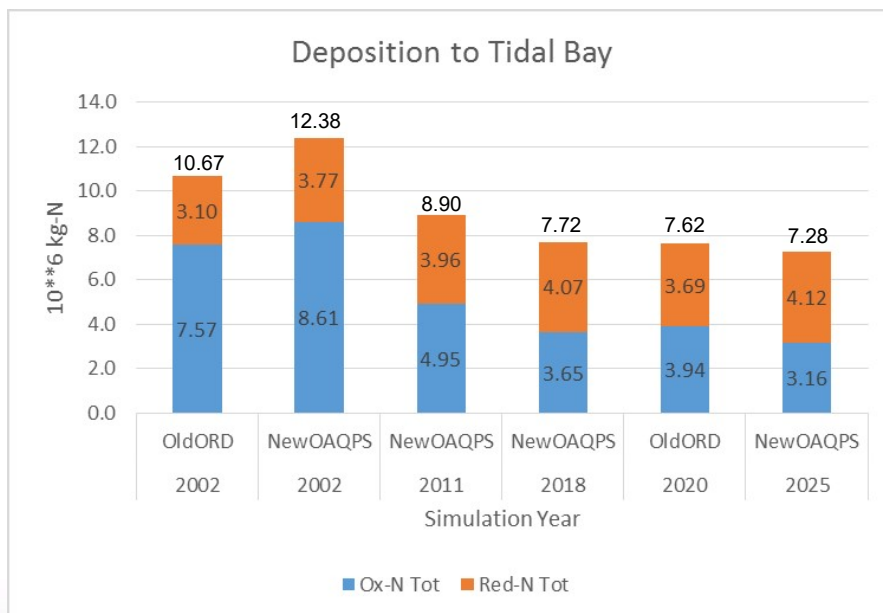
## Bay Deposition Comparison



2002 estimates of Inorganic-N deposition are about 16% higher in the new CMAQ than the previous version (OldORD vs NewOAQPS), yet the new CMAQ 2025 estimate is about the same as the previous 2020 CMAQ scenario.



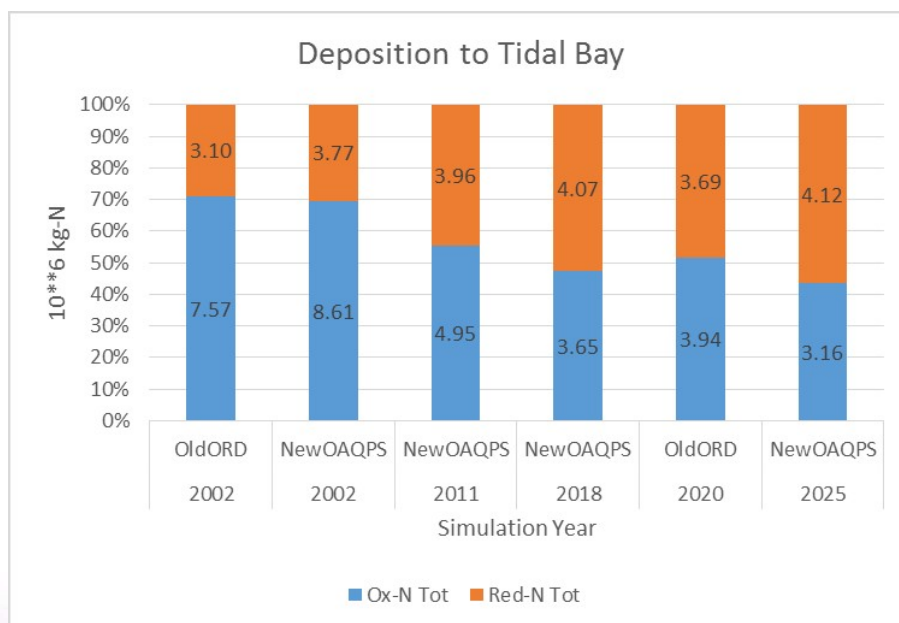
## Bay Deposition Comparison



The time series shows the anticipated diminishing rate of future decline.



## Bay Relative Contribution

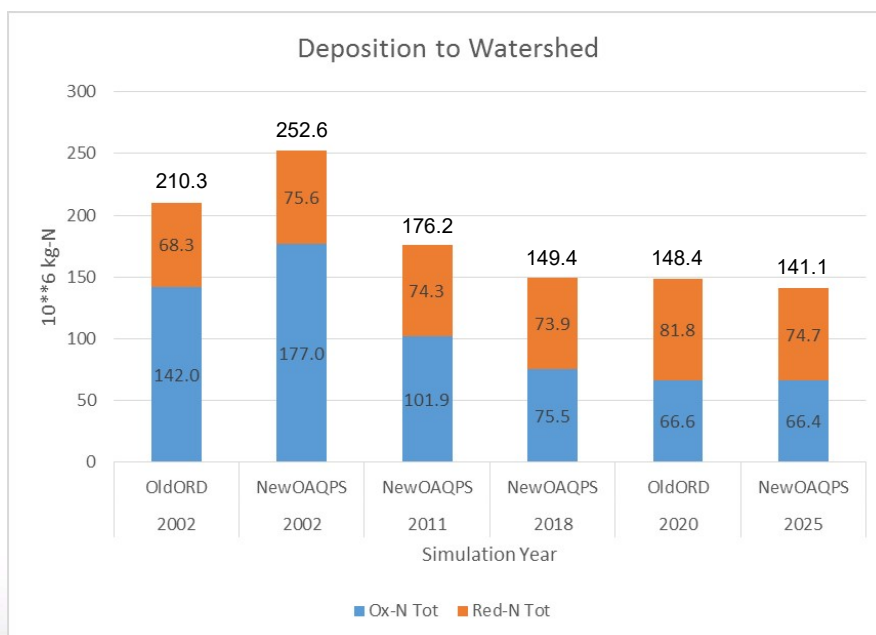


The partitioning is very similar, and the new and old CMAQ scenarios suggest that reduced-N will be the majority portion prior to 2020





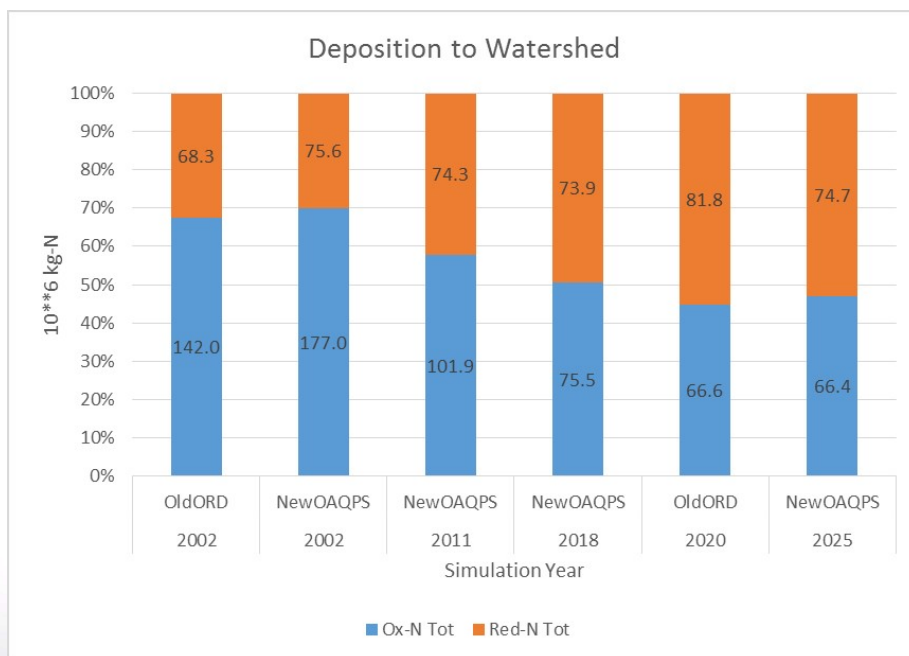
## Watershed **Deposition** Comparison



2002 20% higher, 2025 5% lower



## Watershed Relative Contribution



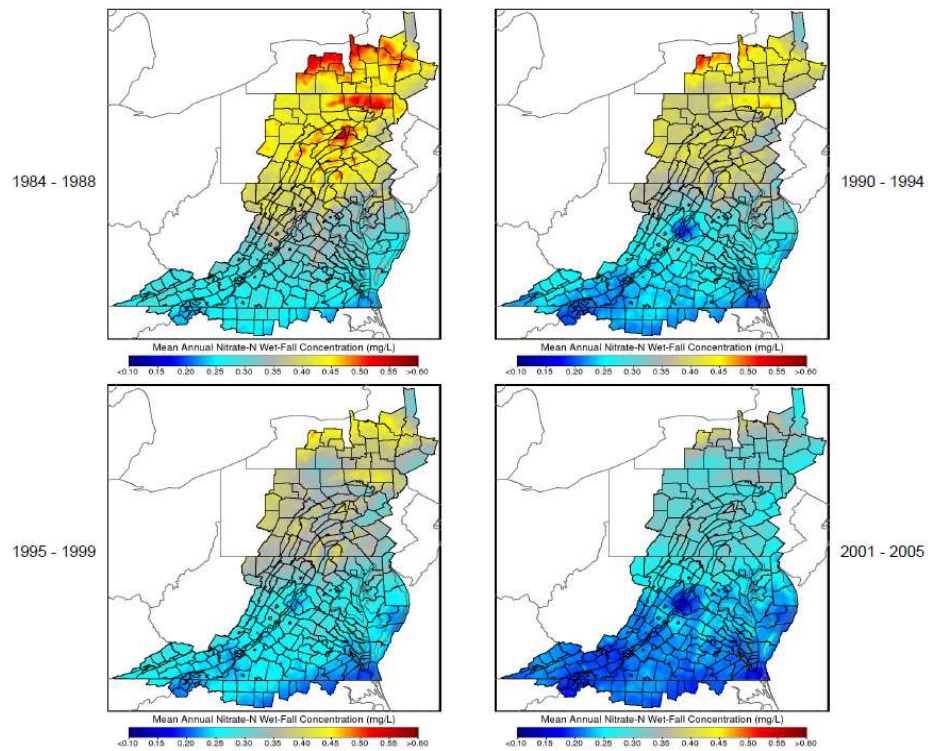


## Summary of Model Changes

- Inclusion of lightning  $\text{NO}_x$
- MOVES replacing MOBILE6 (on-road vehicles, increased  $\text{NO}_x$ )
- Basic Implementation of CAIR accomplished (Major point emissions better known)
- Bi-directional  $\text{NH}_3$  air-surface flux (more wet & less dry)
- EPIC plant demand for  $\text{NH}_3$  fertilizer application (not sales)
- New CAFO  $\text{NH}_3$  diurnal profile (more long-range transport)
- New mesophyll deposition parameterization
- Surface layer cut in half (to 19m)
- Full CONUS domain at 12km
- Land use converted from USGS to new NLCD 2001 & 2006
- Land-Water Mask bug fix
- New convective scheme (improved precipitation simulation)
- Better nocturnal jet representation

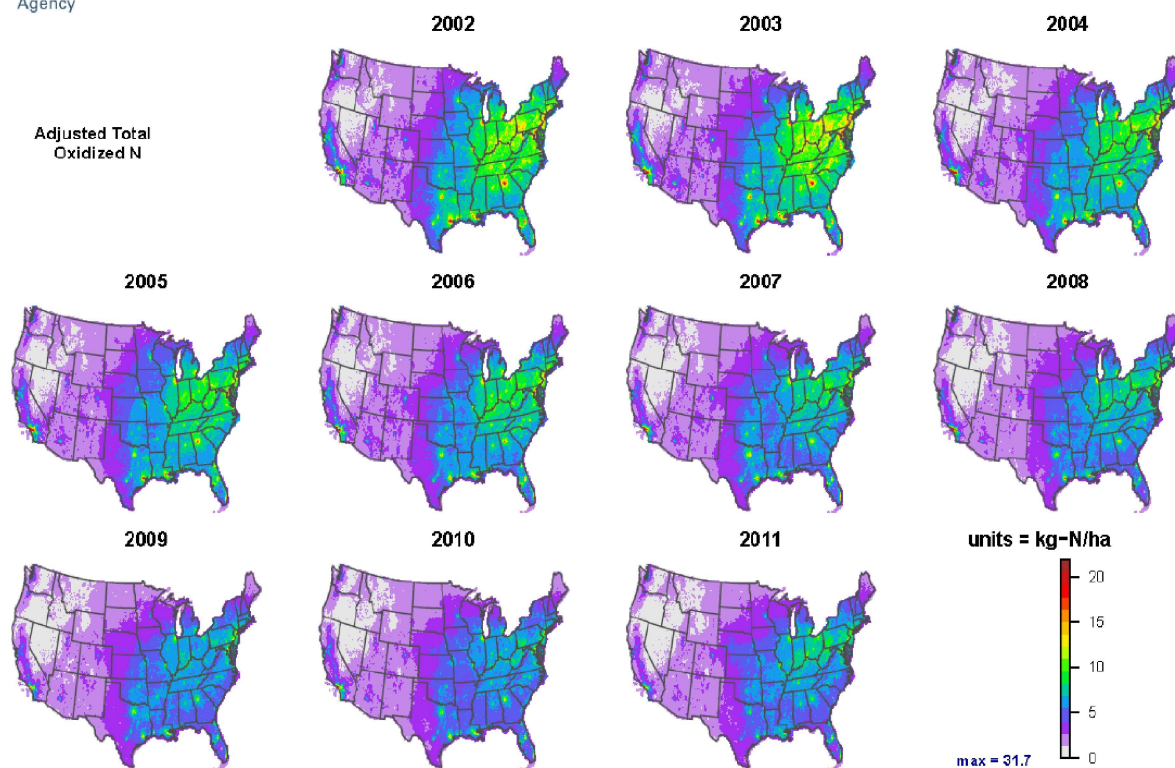


The NADP Regression Model for the 1983-2013 period is also being developed for the 2017 Airshed Model



Mean annual nitrate-nitrogen (NO<sub>3</sub>-N) wet-fall concentrations across the Chesapeake Bay Watershed region during four, 5-year summary periods as estimated by the Phase 2 daily nitrate wet-fall concentration model.

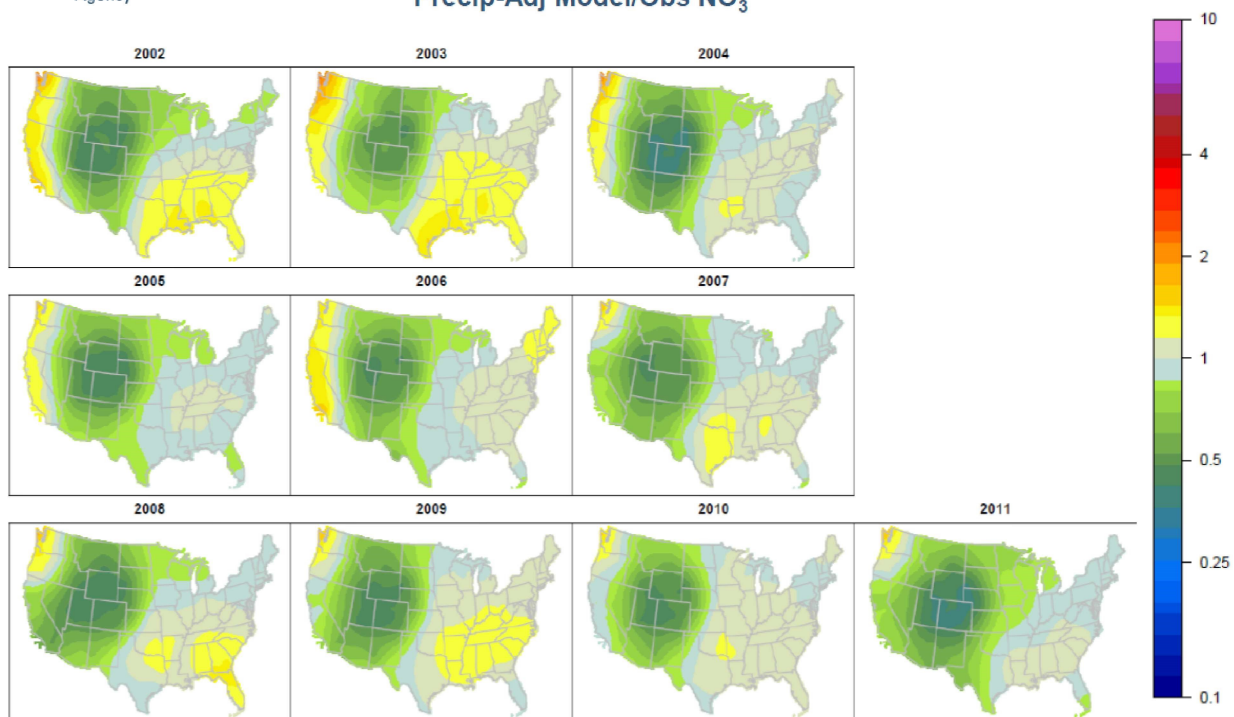
Adjusted Total  
Oxidized N



# Wet Deposition Smooth Bias Adjustment $\text{NO}_3$



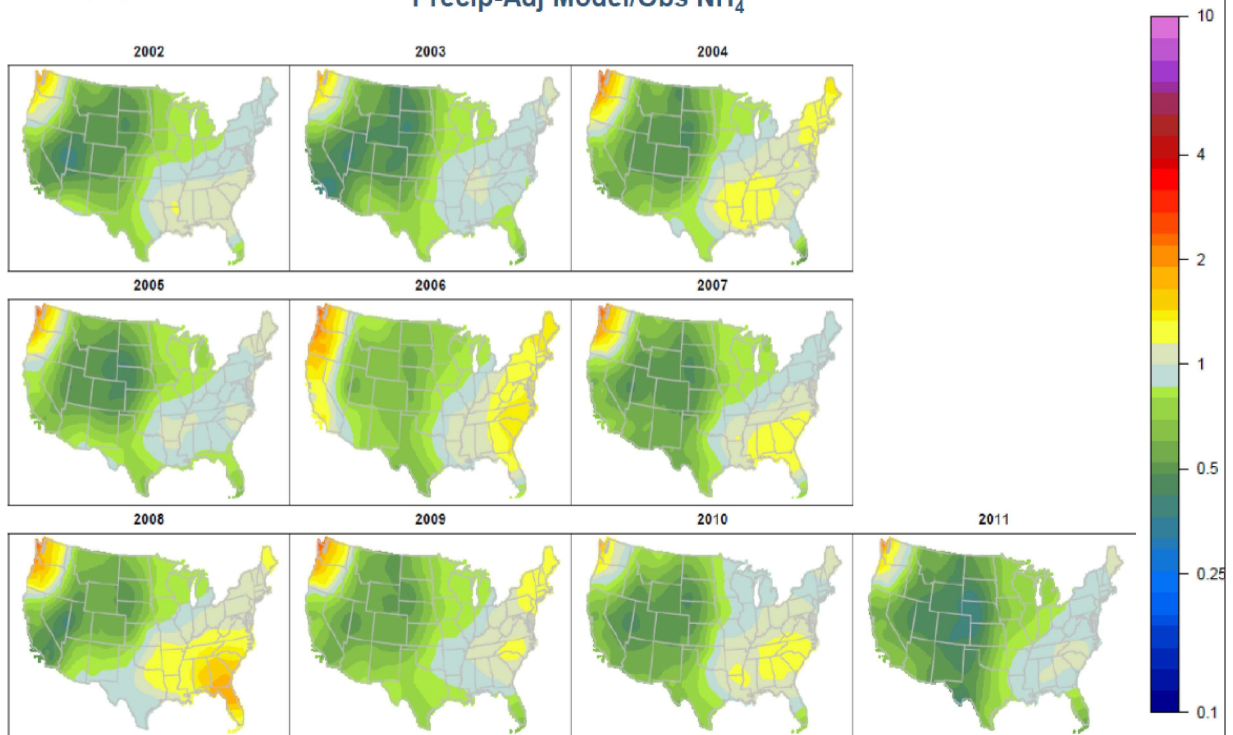
Precip-Adj Model/Obs  $\text{NO}_3$



# Wet Deposition Smooth Bias Adjustment $\text{NH}_4$



Precip-Adj Model/Obs  $\text{NH}_4$



## Conclusions:

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Higher NO<sub>x</sub> deposition is estimated for 2002 with the new CMAQ simulations.

Also, steeper reductions are estimated in deposition from the new CMAQ simulations from 2002 to 2025.

The new CMAQ 2025 estimate is about the same as a previous the previous CMAQ estimate for 2020.

A higher fraction of the total-N deposition is reduced-N deposition in the 2025 estimates.

New model trends from 2002 to 2011 agree well with observed trends in wet deposition and air concentrations.

There is more confidence in the new CMAQ bidirectional model simulations in estimated deposition trends and relative change out to 2025.



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## Conclusions:

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- We've simulated and observed considerable reductions in atmospheric deposition of nitrogen from 1985 to the present.
- Reductions in atmospheric deposition are expected to continue, but at a reduced pace.
- The new Airshed Model is being developed with load estimates from both the bidirectional CMAQ simulation and the Penn State NADP Regression Model. Both elements will be operational by June 2015 and provide new atmospheric deposition inputs for the calibration of the Phase 6 and 2017 version of the WQSTM.



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